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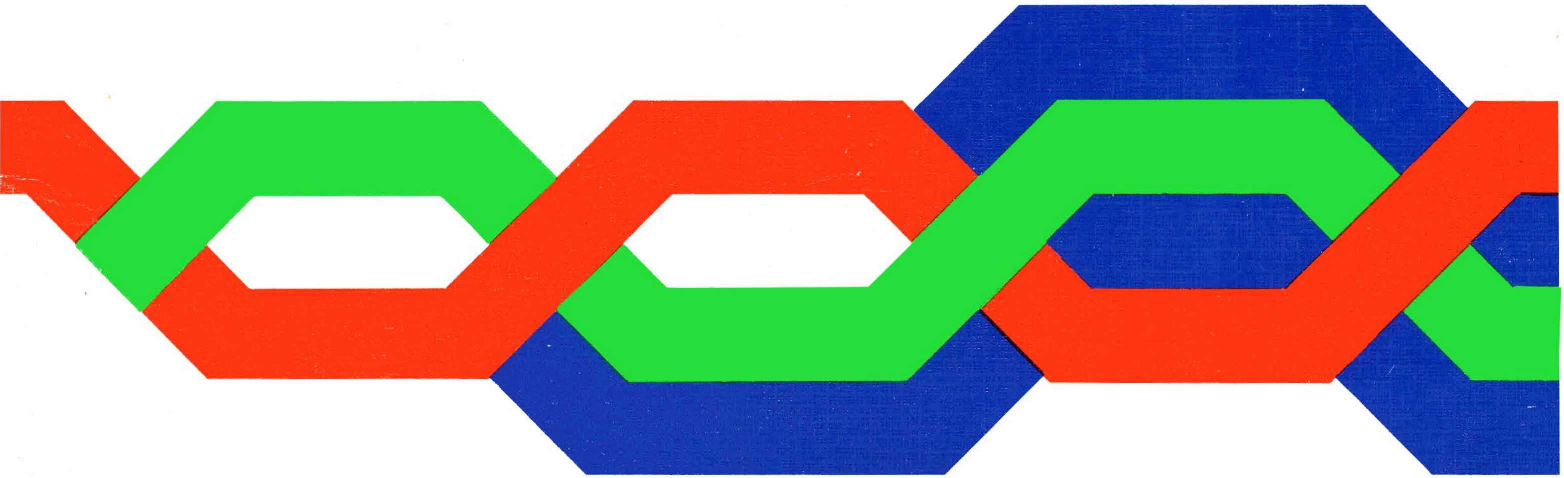

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Editorial

People say about ordeals in general that the first time is always the worst – certainly the first issue of *Maintenance News* proved a trouble to 'put to bed'. The many things that had to be decided made us late for the arrival of spring, but at least we are keeping to time better with our summer number. *Maintenance News* number three will be issued in autumn/winter.

Ideally we would have preferred to await your reactions before publishing again but that would have made us late twice in our first year. However, we hope issue three will be full of contributions and letters from the field. Do please try to get them to us before the end of September or even August. Better still, write now before the holidays.

In this issue we have an article about maintaining power supplies. This should be of general interest but may also reassure the large number of people on power maintenance that this magazine is for them as well as for other maintenance staff.

Which brings me, deviously, to cover design — one of the things that delayed our first issue. I don't know yet what you think of the colourful device on the cover and cannot pretend to discern what was in the design artist's mind. But to me it represents the four strands of maintenance beginning naturally at the customer's end, picking up the line, reaching the exchange and finally the transmission centre.

A fanciful and vague interpretation, no doubt, of what was probably intended as a purely abstract design; but it seems somehow fitting that the longest strand should be associated with the customer, whom all four divisions of the maintenance force exist to serve.

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Systems Maintenance

That's my job and this is how I see it

Before the introduction of STD in 1959 exchanges could be connected to other distant exchanges only by the trunk operator, through trunk circuits. The service given by each exchange could easily be differentiated from the service given by the trunk lines, and there was no incentive for considering the effect of one upon the other.

The advent of STD changed customer attitudes to service; our own responsibilities have changed as well. The customer is no longer encouraged to distinguish between local and trunk service. He is no longer protected by the operators from the effect of faults on the trunk system or from difficulties at the distant exchange. If his call fails, he does not know where this has occured — to him it is a failure of service whether it occurs at his end, on the trunk system, or at the distant end.

In the customer's view all parts of the British telephone service are integrated into one whole by STD; with the growth of ISD he will soon view the world telephone service also as one.

This integration into a nationwide service is being reflected in our maintenance organisation and methods. Ten years ago we could claim that maintenance performance of an exchange was mainly local in its effect, and the maintenance performance of the trunk system affected individual routes only. It is now evident that the performance of plant in Glasgow, the transmission lines between London and Glasgow and the trunk switching centre in London all affect the service experienced by customers making calls between London and Glasgow, just as much as the performance of the plant at the customer's home exchange.

There has also been a change of emphasis in our objectives. In the past it was the fault frequency of the plant that was important. Now the emphasis is on service availability, the probability of a successful call or, conversely, on the out-of-service time of the plant and the probability of a call failing. Maintaining service is our objective, and our prime responsibility to customers is to give a reliable service at a reasonable cost.

The maintenance service depends entirely upon us. No matter how sophisticated and reliable the design of our equipment, faults cannot be entirely prevented. When faults do occur customers rely upon the maintenance staff either to restore service, or to prevent deterioration of service.

To achieve efficiency of maintenance, speed of treatment, and low maintenance cost, there is another major objective: to make the maintenance job easier. This demands reduction of dull routine work by using automatic aids, the provision of speedy information, as well as the rapid detection of faults, and improved facilities for co-operation between staff at different locations.

In striving for these objectives I visualise our work at the THQ end of our maintenance organisation as falling into three categories which I call 'Yesterday', 'Today' and 'Tomorrow'.

First we are developing methods, tools

and aids enabling existing plant to be maintained more easily to give more reliable service in the face of the increased demands of STD, the growth of traffic and the extension of the traffic busy period. This is dealing with Yesterday's plant and there are, and have been, many changes that are contributing towards our objectives — for instance, more automatic routiners, night routining, automatic bank cleaners, various PIPs, the service protection network for the transmission network and automatic circuit busying on transmission pilot failures. These changes help to detect and clear faults more quickly, while doing preventive work more easily and bypassing faulty equipment to maintain service.

Second, as new plant or systems are introduced we must determine the maintenance methods, and ensure that tools, testers and spares are available. As we all know, there are sometimes difficulties that prevent our achieving the success we deserve! I know there are many instances of 'too little, too late', but there are many also of 'just right'. In this category of Today's plant there also arises the need to evaluate and correct teething troubles in new systems, such as relay failures in PCM signalling cards or the noisy transformers in some PCM power converters.

The third category is Tomorrow's plant, which I believe to be as important as the first two. It is vital that we tell our developers the kind of facilities we think will be needed on future plant for it to be effectively maintained. We have done this for the TXE4 system, for our new generation power supply systems and for the 60 MHz coaxial system to name but three. Our aim for the future is that it should be possible to automatically maintain service in the face of plant faults by switching to standby equipment or protection circuits.

Whether concerned with Yesterday, Today or Tomorrow none of us can work in a vacuum. The growth of our traffic, and the changes in our systems are giving rise to problems. We all want to give our customers reliable service, but we want to be able to do so easily. We all need to share our ideas and to mould them to ensure success. We need a ready means of exchanging information.

We have regular conferences between THQ and Regions, Regions and Areas, there is daily contact up and down the hierarchy. We also have the experimental changes of practice committee as a forum for discussion between THQ and our staff associations; and now *Maintenance News* is providing another opportunity for sharing views and ideas.

The objective of systems maintenance as I see it is to ensure that the plant of Yesterday, Today and Tomorrow offers good service to the customer.

Sv6 (01-432 9016)

Maintaining power supplies

Telecommunications power supplies are the ultimate common service — if the power fails the system fails.

Reliability

It follows that power supplies must be very reliable if a reasonable standard of service is to be given to our customers. Reliability targets have been agreed for power supplies to equipment and are quoted in the table in terms of mean time between failures (MTBF). The rates achieved are often lower because of the poor performance of certain obsolescent power plants in the system.

Type of station	Target MTBF
Local exchanges GSCs of less than 500 erlangs capacity Repeater and radio stations	100 years
GSCs of more than 500 erlangs capacity Broadband line and radio switching centres	200 years
Key centres	500 years

Key centres are not easily defined, and each is therefore specified by THQ. The reliability targets are for overall power systems failures causing loss of service by loss of power to the equipment. They do not include power plant faults which do not affect service.

A power system may consist, at its simplest, of a rectifier and battery feeding −50 volts dc at a small UAX. At the other extreme a power system at a large centre may comprise incoming mains at 11 kV with associated transformers and switchgear, two or three 500 kW diesel engine generating sets, a −50 volt dc plant with seven or eight 2000A rectifiers and two or three 16000 Ah batteries. In addition there will be power plants feeding other voltages to line transmission and signalling equipment. The failure of any of the dc power plants can cause a major service failure, and the engines must be ready to start automatically in the event of a mains failure.

The secret of our success in achieving high reliabilities on power systems is the use of batteries of secondary cells. The types of lead-acid secondary cell used by the PO form a super-reliable store of energy and are the basis of nearly all our power systems. When a battery is connected across the equipment busbars it safeguards the supply against short duration mains failures, switching breaks and rectifier defects until maintenance attention can be given. By installing multiple rectifiers to feed the equipment and batteries, and by using multiple standby engine sets, reliability can be raised to almost any level. The target figures are limited by economic considerations.

Reliability may also be improved if the number of different supplies that can cause loss of service is reduced. To this end all new equipment introduced after 1975 will operate from −50 volts dc. This will limit the cost of power plant to securing the −50 volt dc supply.

Maintenance policy

It is not sufficient to design and install very reliable fully automatic power systems. They must receive such attention as they need to maintain their reliability. Some older power plants use unreliable components and need more attention than their modern counterparts. Future designs will need even less attention to maintain their reliability.

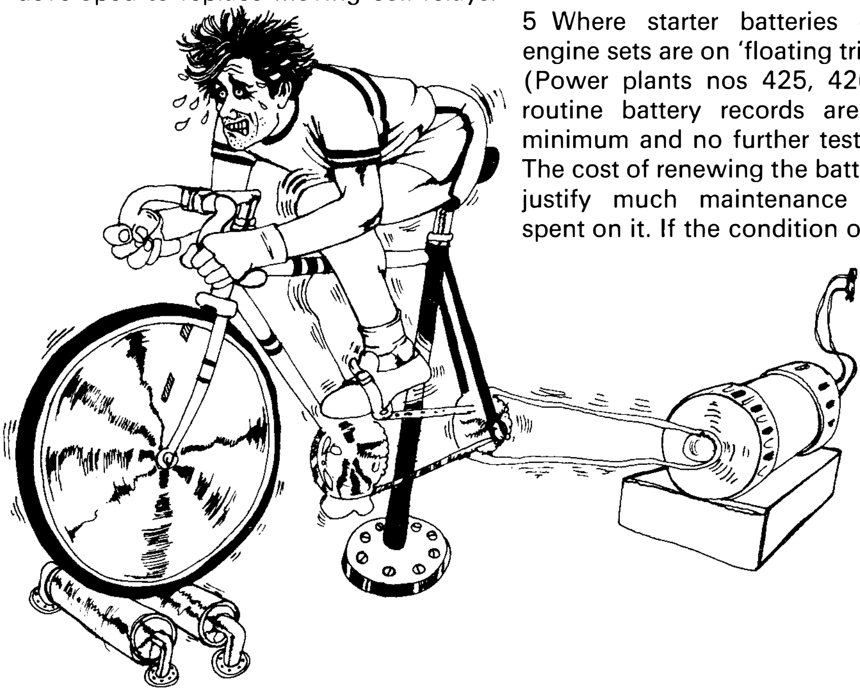
Our maintenance policy is to preserve acceptable reliability at lowest cost, that is to decide the level of attention which each type of power plant needs to function satisfactorily throughout its life without doing any unnecessary maintenance. Changes in techniques and procedures are necessarily slow in the power field because years may elapse before the effect of changes can be observed.

We can illustrate ways in which we are implementing our maintenance policy and taking advantage of new developments and maintenance aids with the following examples:

1 On −50 volt dc 'float' plants (Power plants nos 210, 213, 220, 222 and 225) the fortnightly refreshing charges in many cases have been found to be unnecessary and the periodicity has been increased to four week intervals. This is particularly justified on new and lightly loaded plants. However, local discretion should be used if more frequent refreshing charges are needed.

2 On 'floating trickle charge' plants (Power plants nos 121, 123, 130, 227 and 229) the batteries are normally kept fully charged. Specific gravity readings cease to have much meaning and can sometimes be misleading. The recording of specific gravities has been minimized and replaced to a large extent by the recording of cell voltages which are easier to measure and show immediately when cells get out of step with each other.

3 Solid state voltage monitors are being developed to replace moving coil relays.



Initially they will be used on dc power plants where moving coil relays have caused a lot of trouble.

4 A digital voltmeter is now available to replace the wide range of precision grade moving coil voltmeters currently in use by power plant maintenance teams. The digital meter is more accurate, much more easily read and a great deal more robust than the instruments it replaces.

5 Where starter batteries on standby engine sets are on 'floating trickle charge' (Power plants nos 425, 426 and 432) routine battery records are kept to a minimum and no further testing is done. The cost of renewing the battery does not justify much maintenance time being spent on it. If the condition of the battery

gives cause for concern and the rectifier is correctly adjusted then the battery should be changed without further testing being done.

6 Overhauls of standby engines have traditionally been done at five year intervals. Experience with about 2000 engines suggest that this is not required if instructions are followed and test running kept to a minimum. Overhauls should now only be done if the annual test run reveals defective performance.

7 Improvements in anti-freeze compounds during the last few years have allowed us to discontinue adding Alfloc to engine cooling water as a separate corrosion inhibitor. For the same reason we have extended the time between changes of cooling water from one to two years.

8 Lubricating oil in standby engines is being changed far more often than is really necessary. On-site tests to decide the need for an oil change are being devised.

Specialist teams

Authority was given in 1952 for the setting up of specialist power maintenance teams. The amount and disposition of power plant at that time was such that only a few Areas found it advantageous to set up these teams. However, increases in size and complexity of power plant and particularly the increased number of engines has altered attitudes and most Areas now have power specialists to do the major routines on power plants. Although work practices will vary with work load from Area to Area it is not intended to burden specialists with simple routine maintenance which can be done by station staff. Their job is to do any power maintenance work requiring either special test gear or expert knowledge.

Fault records

In addition to doing routine maintenance and fault clearance on power plants it is vitally important to record details of faults and difficulties. We cannot deal with faults and difficulties unless you tell us about them. All faults, whether found during the performance of routines or in response to a malfunction should be recorded on the power plant fault dockets A237. Other difficulties should be recorded on the usual A646. These reports form the basis of all progress in power plant maintenance and development.

Sv6.3.2 (01-432 1412)

Centralised maintenance for the new generation of exchanges

Exchanges in the new generation of switching equipment — crossbar and electronic exchanges — offer certain features which are not available in Strowger exchanges. They are designed to operate unattended for long periods, shield customers against call failures due to equipment faults (second attempt feature), and provide a printed record of failed calls. In addition, electronic equipment is mounted on plug-in assemblies which can be removed from the exchange and sent to a central point for repair.

These features make possible a new kind of maintenance organisation, in which exchanges are grouped together for maintenance purposes. Such a group of exchanges is known as an exchange maintenance unit (EMU), and is maintained by a team of engineers, whose activities are controlled from an exchange maintenance centre (EMC). It is believed that this form of organisation will make the best use of the facilities of common control exchanges, and will result in the most satisfactory working arrangements for the staff.

A field trial to test the proposed organisation has been running for about a year in Coventry Area. Seven TXK1 exchanges in and around Coventry (Binley, Chapel End, Bedworth, Tollbar, Highway, Berkswell and Dunchurch) form the EMU, and an EMC has been established in Binley exchange — the largest exchange in the group. An AEE runs the EMC, and he has a team of five TOs and three T2As to carry out all the maintenance work on the switching equipment in the exchanges. He has a CA to assist him with the day-to-day administration of his EMC.

The novel aspect of this method of maintenance is that all the fault print-out from the exchanges in the EMU is transmitted to the EMC at Binley, where it is recorded on teleprinters, one for each exchange. A further refinement will be added shortly with the arrival of equipment which will enable all the print-out from the seven exchanges to be concentrated on to a single teleprinter. Punched tape outputs from the teleprinters are sent regularly to a computer centre, which analyses the data and returns a summary to the EMC. The AEE at Binley can then direct his team members to attend to faults at particular exchanges, and can programme this work, together with the necessary scheduled work, so that frequent visits to an exchange can be avoided.

It is proposed to extend the field trial by establishing two further EMUs: one comprising TXE 2 exchanges and the other containing a mixture of TXE 2 and TXK 1 exchanges. It has not been possible to introduce centralised maintenance for TXE 2 exchanges until now, because the fault print-out at these exchanges is recorded as a pattern of coded marks on sensitised paper, which cannot readily be extended to an EMC. However, THQ has developed a print-out interface for TXE 2 exchanges that converts these coded signals into teleprinter format, which can be transmitted to a central point. Two of these equipments have been constructed, and are successfully on trial at Hullbridge TXE 2 (Southend Area) and Loose TXE 2 (Canterbury Area). Additional equipment to enable the print-out from a number of exchanges to be concentrated is currently being commissioned in the THQ Circuit Laboratory.

With the completion of this print-out equipment, the additional EMUs should be operational by the end of 1973, and should reduce staff travelling time.

It has not yet been possible to make an objective comparison of the maintenance of the EMU exchanges with other TXK1 exchanges being maintained in the traditional way, but a detailed analysis will be made in due course. In the meantime, indications are that the EMU organisation is running smoothly and efficiently.

Sv6.1.3 (01-432 1396)

Routiners and testers for telex exchanges

Most switching equipment and all trunk circuits at inland telex exchanges are at present tested manually. This job is tedious and takes up a lot of time and we are rarely able to test selectors or relay sets more often than once a month. If a switch or relay set becomes faulty just after passing a routine test, then it may remain in service for a long time causing many calls to fail.

However, development of automatic routiners for telex exchanges is now well under way. These routiners will operate at night and at weekends controlled by a fault recorder. Each piece of equipment and trunk circuit will be tested nightly, with a more comprehensive test at week-ends. We expect many telex exchanges will have enough equipment to justify installation of routiners during the next few years.

Four types of routiners will be needed, to cover group selectors, time zone metering equipments, final selectors and trunk circuits. Each will have the same type of access and test control circuitry, and this standardisation will make the job of routiner maintenance easier. Special test circuits have been devised to suit the particular equipment under test.

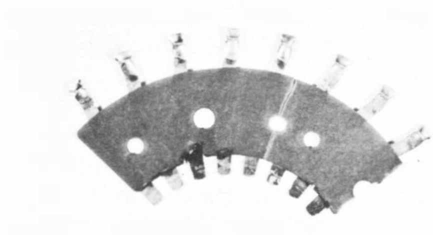
The routiner for trunk circuits — and associated relay sets — will include a telegraph transmission test circuit. This will set up a call over each trunk to a special loop test relay set fitted in distant exchanges. Test signals will be transmitted around the loop and the distortion of received signals checked automatically by the routiner against set limits.

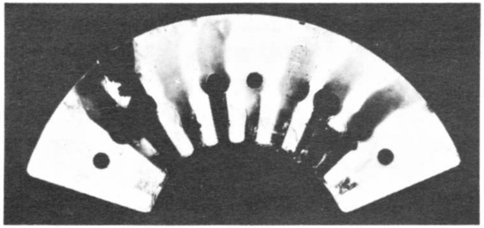
Development of a group selector routiner has been completed, and the first twelve models installed. An order for a large number is now being placed. Prototype models of each of the other three routiners have also been made and are now being tested.

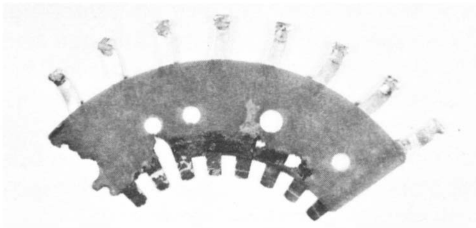
Another important test equipment is planned to enable checks to be made at telex stations without needing co-operation from the exchange. A prototype tester which prints back distortion values of transmitted signals, and also supplies test messages to check receiver margin, has been tried out successfully. We hope to obtain a quantity of these as an interim step, but a more comprehensive design is planned which will also operate outside working hours as an automatic routiner for telex stations.

Sv6.4.2 (01-432 1318)

Selector bank failures in telex exchanges







Over the past few years, we have received only a few isolated reports of selector bank failures in telex exchanges. Recently however a number of failures occurred which affected two exchanges and we thought it would be useful to mention some points which came out during the investigation.

Each of the failures has caused burning and blackening of the bank insulation, as shown in the photographs. The insulation between contacts, and between contacts and bank clamping bolts has been destroyed by heat due to tracking. Usually the existence of this trouble has only been noticed when banks are being cleaned, andthe full extent of damage only seen after the bank has been dismantled.

All but one of the banks concerned had light duty (brass) contacts, and it seems that banks with heavy duty (nickel silver) contacts are rarely affected. Most of the adjacent brass contacts also show noticeable wear, and brass dust had accumulated between some of the contacts. Particles of brass may become embedded in the PVC separators due to pressure from the wipers, and may also get into the bank between the separators.

We conclude that if debris produced by wear of the contacts is allowed to accumulate there is a risk of serious bank damage. The 80+80 volts used for telegraph signalling no doubt makes the situation more critical than in telephone exchanges.

Most telex exchanges have heavy duty bank contacts, but a small number of exchanges installed by ATE and STC do have the light duty type. Particular attention to the condition of wipers and banks at these latter exchanges is obviously important.

If anyone has other points concerning bank faults which they feel are worth publishing, we should be pleased to hear from them.

Sv6.4.2 (01-432 1318)

The service protection network

The Managing Director gave approval in 1967 for the expenditure of £10·7m to provide a Service Protection Network (SPN). The Network, planned to have a total system length of 6000 km — one tenth of the estimated 1975 traffic system length — was initiated to protect service on the main trunk cable routes, because of the increased traffic carrying capacity of coaxial line transmission systems and the effects of their failure upon the rapidly growing STD service.

The Network is largely based on the provision between selected repeater stations of standby 4 MHz and/or 12 MHz regulated line sections (RLS) on coaxial cable pairs; the Network also utilizes microwave radio protection channels when these are not in use for radio or occasional television programme purposes. Access to the radio protection channels is provided either by the extension of video ties from television network switching centres (NSC) to repeater stations, or by direct coaxial telephony ties between the radio and repeater stations.

Besides being used to restore service under breakdown conditions the SPN is also used to off-load traffic from working systems to facilitate planned service-affecting works such as modification and modernization of transmission equipment or rearrangement of working hypergroups.

Regions were asked in July 1970 to provide *ad hoc* patching and switching facilities to allow spare coaxial links, early SPN links and radio protection channels to be used for protection prior to the provision of fully engineered switching. These facilities, which vary with the size of the repeater station and number of SPN systems available to them, enabled the Network to be used during 1971 and 1972 to temporarily re-route 1327 hypergroups for planned works, and 299 for emergency restoration during breakdowns.

There are now over 60 SPN systems of all types in service and a similar number of systems is programmed for completion by the end of this year. By 1976 the planned SPN between main nodes will be virtually complete.

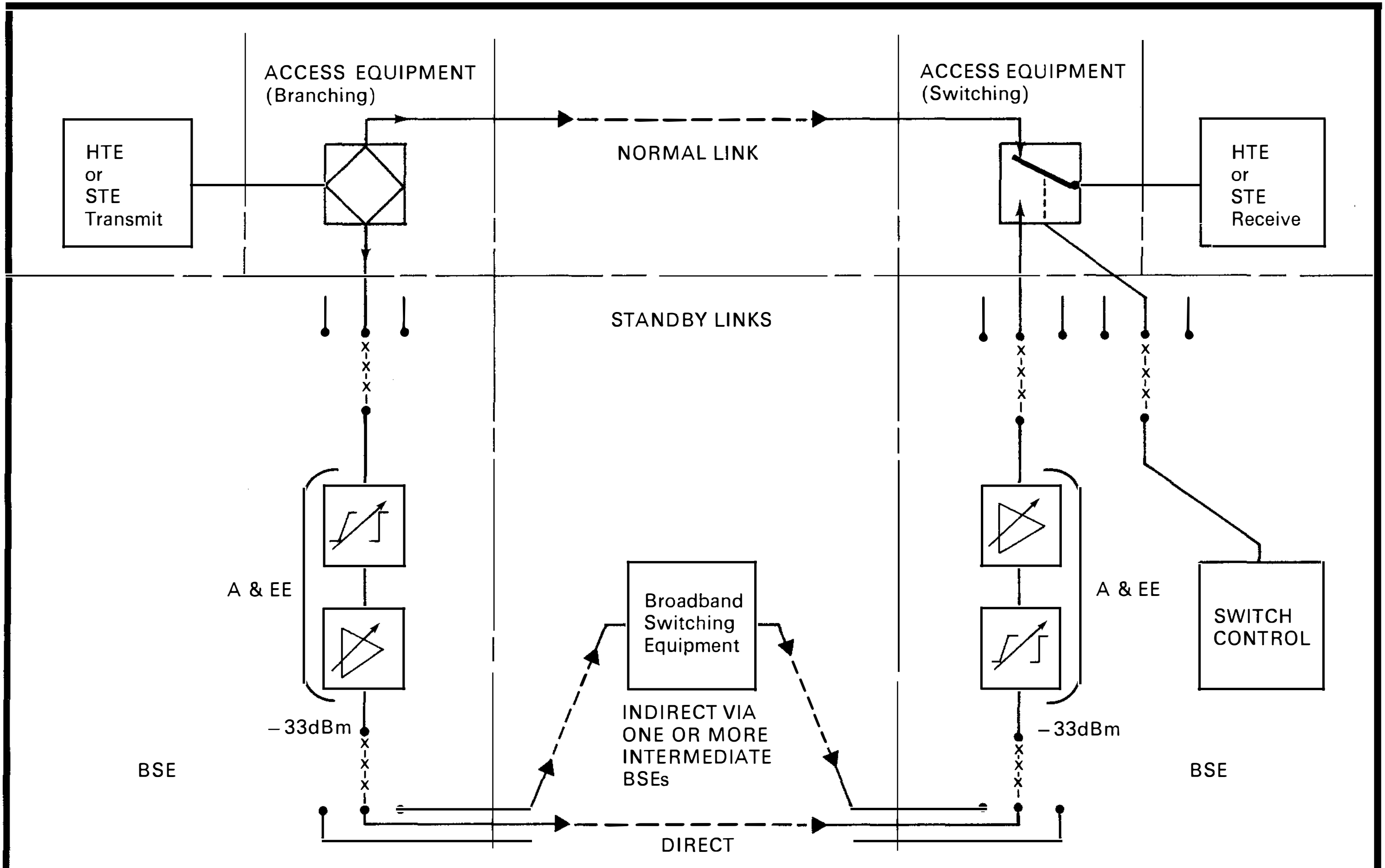
Spare hypergroup translating equipment exists or is programmed to be installed at over 40 selected stations; it is planned for at the majority of 12 MHz coaxial terminal stations to enable three 4 MHz sections to be derived from a 12 MHz RLS.

When 60 MHz coaxial line systems become available it is planned to use some of their spare 4 MHz broadbands to provide direct SPN links, for example, between London and Birmingham.

Manual switching equipment is programmed to be provided at over 100 stations and installation of the first of these is due to start in December this year.

The manual switching equipment will be in two parts; an access and switching equipment (ASE) and a broadband switching equipment (BSE), both using 62-type construction practice.

The ASE consists of a single shelf; it has mounting positions for up to four hybrid branching units and four high



Note: Only one direction of transmission shown.

speed switching units, and to gain access one pair of these units has to be 'cut in' at each end of the working link requiring protection. The branching unit is connected in the transmit path and the switching unit in the receive path. This equipment may be used in either a 12 MHz or a 4 MHz broadband traffic link. In the former case it is associated with a hypergroup translating equipment (HTE) and in the latter with a HTE, supergroup translating equipment (STE), or, in a smaller number of stations, a 4 MHz or 12 MHz coaxial system terminal equipment. Traffic links that cannot be served initially by the SPN will be provided with dummy printed circuit cards in place of the switch and hybrid. The switching units include a *Standby in Use* lamp and facilities for extending supervisory conditions to the BSE.

The BSE, which includes a 62-type 9ft rack, provides facilities for terminating in-station cabling from 50 ASEs, 12 standby coaxial line systems (SPN systems), as well as for two spare hypergroup translating equipments, six variable station cabling equalizers and two tie circuits. Two patching panels are provided on this rack, one to terminate the transmit cables and one the receive cables. The latter panel also terminates the cables to a variable residual equalizer shelf. The station cabling equalizers have amplifying, attenuating and cable simulating facilities suitable for the 4 MHz and 12 MHz frequency bands of 60 to 4092 KHz and 300 to 12 500 KHz. The equalizers are provided as required and allow patching between the working and standby links to be at a standard level of −33dBm. The BSE also has a key and lamp unit which provides the control keys and facilities for selecting the high speed switch associated with any one working link of up to 50; also for a lamp indication of the number of the switch selected; for receiving supervisory signals from those switches connecting a standby link to traffic equipment; and for illuminating a lamp matrix to indicate which of the switches are in this condition. There is also provision for fitting a telephone jack.

Switching is on a unidirectional basis, the switch being at the receiving end of the transmission path, but in practice both directions of the failed link are often switched to the standby SPN link. This switching is not simultaneous and need not be so.

The interruption to a transmission path due to switching of the high speed switch should not exceed 20 microseconds; this short switching time is of most importance when a working link is taken out of service for planned work and when a previously failed link is restored to service.

The management of the SPN is vested in the National Network Co-ordination Centre (NNCC). One of NNCC's objectives is to formulate and up-date plans for the use of the Network to restore service under breakdown conditions and to facilitate planned service-affecting works. The national and regional NCCs are responsible for co-ordinating the use of the SPN and also the order of priority of restoration should concurrent failures occur on a number of broadband links, particularly in respect of submarine cable links. For each station in the SPN there will be a switching plan listing primary and secondary restoration routes for hypergroups and line systems for each of which the attenuation and slope of the cabling between ASE and BSE will be known. From this information the settings of the patch panel amplifier/equalizer controls can be determined and recorded in a card index.

When failure of a hypergroup occurs the fault is first localized. Should, for example, a RLS prove faulty, the SPN link or series of tandem links are selected, patched through at any intermediate SPN stations and at each end of the link. For ease of patching the patching panel points are labelled either with the hypergroup number and station code of the distant hypergroup terminal, or in the case of regulated line sections, the RLS designation letter and code of the distant RLS terminal. Amplifier/equalizers on the BSEs are then adjusted to their recorded settings and the overall transmission level checked.

The appropriate ASE switch is then selected and operated from the associated BSE and a check made to ensure correct changeover to standby has occurred. Should both directions of transmission require switching the ASE switch at the other end of the link is operated similarly, co-operation being necessary between the stations concerned. To restore traffic to the normal link the ASE switch has again to be selected and operated from the BSE, the appropriate switch being indicated by the illuminated lamp on the lamp matrix.

The future of the Network is now being discussed. At THQ a committee formed from Network Planning Department, Service Department and Telecommunications Development Department personnel is considering for instance whether automatic switching is required and what form the Network should take to protect digital systems. One recent development is that of 60 MHz regulated line sections. These RLSs will have one standby system to protect eight traffic systems in the same coaxial cable and changeover will be automatic.

The SPN is proving useful in helping to reduce interruptions to traffic and loss of service due to planned works and faults, especially cable faults, which frequently have long outage times. There is evidence to show that as the Network grows further improvement can be expected. Other benefits include improved circuit performance by giving better facilities for investigating faults and improvement in maintenance efficiency by enabling more maintenance work to be done during normal working hours. Besides operational advantages the SPN is also achieving significant reduction in loss of revenue by increasing the availability of trunk circuits.

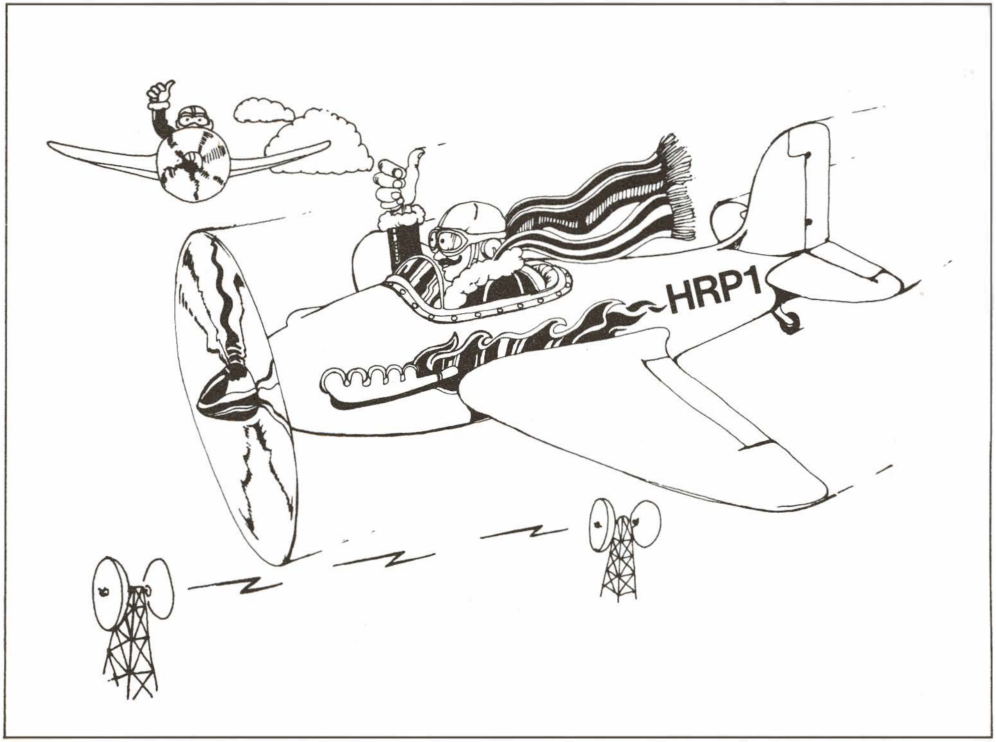
Sv 6.2.4 (01-432 1325)

Introduction of hypergroup reference pilots

Overall reference pilots on groups and supergroups are now an established and proven cost-effective maintenance aid. The transmission of a continuous pilot enables these circuits to be monitored and routine tested without taking them out of service, and enables faults to be located without assistance from the transmit terminal for each direction of transmission. Pilots thus reduce maintenance and out of service time.

In the absence of a dedicated reference pilot for a hypergroup link, which has a nominal capacity of 960 audio channels (4 MHz total bandwidth), it is common practice to select a suitable supergroup that is co-terminal with the hypergroup, and utilize the supergroup reference pilot (SRP) for the maintenance of the hypergroup. The disadvantages of this arrangement are:

i The provision of the chosen SRP is not always in the preferred position



(between 1-2 MHz) for showing maximum annual temperature attenuation changes.

ii The non-standard position of the SRP reference can cause confusion at sub-control stations, especially where a large number of through hypergroups are working. There may be a different SRP reference for each hypergroup, perhaps even a different SRP reference for each direction of transmission.

iii Re-arrangement of the selected supergroup can require a new set of reference measurements to be taken.

iv Sub-control stations can have difficulty in detecting the SRP in the 4 MHz band because the SRP, 411·92 KHz in the basic supergroup, is injected in a 900 Hz slot between channels 1 and 2 of group 3, whereas a dedicated pilot of 1552 KHz would lie in an 8 KHz inter-supergroup slot.

At the present time there are some 880 hypergroup links in service and the routings are in many cases complex. In the simplest case the hypergroup terminal stations are co-terminal with one regulated line section (RLS), and the performance of the hypergroup link can be determined from the RLS pilots. In the larger centres on the HF network it is more likely that the hypergroup terminal is not situated at the same station as the RLS terminal. In this case the hypergroup is routed over a short amplified or unamplified tie between the RLS terminal and the hypergroup terminal. A large number of hypergroups are also routed over two or more RLSs in tandem interconnected with short ties. Where the RLS has a capacity exceeding 4 MHz the hypergroup routing may include hypergroup translating equipment.

It is in such cases that a hypergroup reference pilot (HRP) would be of most benefit. To minimise the cost of providing the necessary equipment it has been decided that provision of HRP generating apparatus will initially be made only at those terminals that control hypergroups routed over tandem RLSs. There are 72 stations of this type out of a total of 259 hypergroup terminals.

Two types of pilot measuring/monitoring equipment will be provided; a terminal measuring equipment, for measuring the level of the basic HRP (1552 KHz), and a portable intermediate measuring equipment for measurement of the HRP in either of the three bands 0-4 MHz, 4-8 MHz and 8-12 MHz after hypergroup translation stages, which produce HRPs at 1552, 6880 and 11 096 KHz.

Sv6.2.1 (01-432 1368)

Working party overloads on coaxial line links

Reports of coaxial line link failure due to the application of incorrect test signals are increasing. It is believed that these represent only a small proportion of the total failures that occur. The majority of reports are cleared FNF.

One of the more usual causes of such failures is overload owing to the application of –8dBmO signals at –37dBmO points. Such situations often occur for short periods when test oscillators are first connected (at the last send-level setting used) until they are readjusted to the correct level. Overloads last for even longer periods when someone connects a test oscillator, at the wrong level, and then goes off to lunch! A solution to this problem is to develop the habit of turning the output control of test oscillators to the minimum setting before removing the send cord, each time the oscillator is used.

Another cause is the test cord being inadvertently plugged into the high-level calibrate/monitor sockets of oscillators no 110 & 111, instead of the send sockets. THQ are considering fitting shrouds on the calibrate/monitor sockets, but in the meantime, please take care.

While the simultaneous application of a number of OdBmO test signals may seldom lead to a complete system failure it frequently causes a severe degradation of performance. It is impracticable to impose limits on the number of simultaneous test signals, particularly at channel level. However, the aim should be to keep to the minimum the number and period of use of test signals especially during the busiest traffic hours. The effect of a number of test signals will be more serious if they are derived from a common (in-phase) source, and non-standard arrangements for deriving a number of OdBmO test signals should not be employed.

The symptoms of severe overload on coaxial line links may be those of a disconnexion. If during the initial diagnosis of such a failure the possibility of overload is overlooked the results of subsequent tests become more and more baffling and out of service time increases until someone thinks of checking for overload. If the initial diagnosis indicates a disconnexion, for example both incoming pilots failed, then before faulting any further a check should be made as to whether an overload exists by removing the 'traffic in' links of the direction affected.

To sum up

Take care to apply only the correct test signal level.

Avoid, as far as possible, the multiple application of test signals.

Do not leave unnecessary test signals connected.

Remember that a careless approach to the application of test signals can cause serious failures involving 900 or more circuits.

Sv 6.2.1 (01-432 1366)

Subscribers apparatus maintenance policy

This article explains how we at THQ view the maintenance needs of the terminal apparatus used by our 10 million customers, and also describes how we are involved.

First, the principal object of a faulting visit to a subscriber is to restore service in the quickest and most economical way. This may seem obvious, but we should all keep it in mind. Having myself seen a PABX TO wrestling with a plan set N625 on a Managing Director's table for an hour and a half, I am convinced you have to make an early choice between clearing the actual fault, and restoring service by other means. For our part we have to influence the design of apparatus to enable you to replace parts quickly, and organise provisioning so that spare parts are available when you need them.

We find, and you will probably agree from your experience, that around 95 per cent of failures are due to mechanical reasons, because the most fault prone parts are items such as the bell set, dial, cord, transmitter, receiver and the gravity switch. Close inspection often shows up the trouble fairly readily, but we know there is more to the job than the figures show. There is a tremendous amount of scope for experienced men, in learning about new apparatus being introduced, and in using judgement and ingenuity to meet fresh situations and find solutions. Many faultsmen might well agree that the continuing novelty and meeting different customers are in fact the best parts of the job. Perhaps you would like to let us know what are the worst parts, for this magazine is for your views from the field as well as ours from THQ.

Secondly, accurate fault returns are required. At THQ we need some measure of the fault rate on subscribers' apparatus taken as a whole – by means of the A51 record – to plan for a steadily reducing fault rate. As might be expected, the greater the usage rate of subscribers' apparatus, the higher the fault rate, and therefore the more costly it is to maintain. Business users clock up fault rates about 4 times that of residential users, but because the higher proportion of our new installations are residential, the average fault rate is declining slowly for that reason alone. In your particular exchange areas therefore, the average fault rate depends partly on the mix of business and residential users.

We also need checks on individual major items, for instance telephone no 746, and on re-designed or fresh components, such as transmitters no 15 and dials no 52. These checks, made from subscribers' fault history record cards, enable us to identify and quantify both good and bad parts; we then advise the Development Department of strengths and weaknesses in design. (There is another article in this issue dealing with reliability trials).

Thirdly, THQ and local management need to know the costs of providing the service as these affect rentals too. So forms have to be filled in regularly to measure average fault clearance times (manhours per fault). In the interests of productivity, we have to plan for a reduction of these times.

The frequency at which faultsmen visit installations and the time spent on visits have, of course, a profound effect on costs and at all levels we have to strive for improvement. At present, visits to the simpler telephone installations take place about once every four years on average – the figures would be much higher for the larger and more heavily used installations. As to time spent on visits, you will be interested to know that one of the results of a major study of Technician IIA faultsmen a few years ago showed that the average time occupied in dealing with a fault was close to 20 minutes, plus a further 8 minutes average travelling time one way, between faults. This excluded time at the TEC, stores, lunch and tea break, waiting for co-operation and so on; it was an average of city, suburban and rural exchange areas, some of which obviously involve longer times or more difficult faults than others. Clearly if that sort of time is to be sustained or improved, THQ have a responsibility for designing apparatus which is either readily maintainable or readily replaceable. Incidentally, present figures show that better than four out of five faults are cleared by repair on the spot.

There are many other factors in subscribers' apparatus maintenance which further articles should deal with, such as planning the order in which faults should be attended to having regard to class A or class B categories, second visits and repeat faults. For the moment, however, I hope this article has interested you in three main aims of policy: quick and efficient restoration of service; accurate fault returns to be used for improving the plant and the methods of fault clearance; and keeping costs down.

Sv5 (01-432 9015)

Plant reliability surveys

Form A51 is the monthly plant fault summary produced for each RSC showing the number of customer reports, and the number of faults discovered in exchanges, underground plant, subscribers' apparatus, in call offices and so on. These results are divided by the number of connexions and the number of stations in the RSC area to produce overall indices in terms of reports and faults per station per annum.

Comparing indices between General Managers' Areas, or between exchange areas, leads to certain conclusions such as the 'U/G plant round there is poor' or that 'heavy rainfall in October pulled that Area's results down'. Clearly the indices have limited but valuable use. Over the years they show, for instance, that faults on overhead plant have been reducing very convincingly (see attached graph of national figures), and that public call office faults are at last responding to strengthened equipment.

They show too that faults per station or connexion in the plant groups of exchange equipment, subscribers' apparatus and local lines, have shown little or no improvement over the last five years. These groups, by the way, are the three largest in terms of manpower, using 15, 12 and 11 million manhours respectively in the year 1971-2. If this manpower is to be used more effectively, we must direct our efforts at compiling more knowledge of faults, so that design attention can be effectively applied to reducing liability to failure. We need to know:

a what are the parts of the plant most prone to faults

b in what ways the plant items fail

c why they fail.

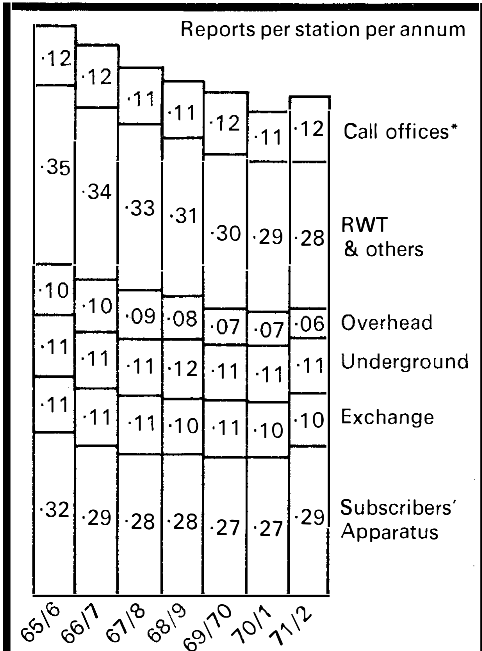
Consider subscribers' apparatus: this comprises a mixed bag of equipment from the simple telephone and bellset, through plan sets, to PMBXs of various sizes. An average fault rate of say 0·25 per station per annum is not a very helpful figure, but we do know that of our 17 million stations a high proportion comprise a straightforward telephone. If we study a sample of several thousand phones and analyse from the history cards where the faults arise, we should get the bad items in a 'pecking order'.

By tackling the big population items, moreover, we ought to produce a big impact in reducing need for faulting visits.

Unfortunately, the history cards proved not as reliable or as clearly written as we had hoped, and showed signs of holding on to the mysteries we had wanted them to yield. Nevertheless by taking a large enough sample it soon became obvious what the main causes of trouble were. It will be no secret that the bell, the dial, the gravity switch and transmitters led the field (not necessarily in that order) as calling for improved attention.

This then is one of the methods used to study fault behaviour of a particular type of subscribers' apparatus. Usually THQ officers visit selected RSCs and either study the cards or get them photographed to take away for study, to limit the degree of interference with day-to-day work at the control.

Whenever we introduce new apparatus items, or redesigned components, hopefully with improved performance, there is no existing population and an alternative study method is used. The apparatus is put into service for some months in selected Areas with the co-operation of the fitting/installation staff. The fault record card for the particular item is held in a specially designed envelope which indicates that the particular installation requires the RSC staff to give each fault and clear a coded number indicating the cause of failure. Subsequently the information from the cards is forwarded to THQ for computer summary and analysis.



*Reports per call office much higher (24 in 1971/2)

The period of trial is often as long as a year for the fault rate to settle down and to collect enough faults to be confident of results. The number of items observed has to be related to the expected fault rate. If for instance an existing type of dial has a fault rate of one and a half per cent or three faults per 200 items per annum, a trial of 200 dials of a new type might give us only two faults. We need to install at least 2000 so that we can collect evidence to show with confidence that with 20 faults in a year — compared with the previous type's 30 faults — we really do have a better dial.

It is worth mentioning that what sounds like only a small percentage improvement in fault rate of, say, telephone 746, from 0·20 to 0·19, produces a reduction of 100,000 faults a year or a maintenance cost reduction of almost £0·5m a year. By 1980, because of inflation the same number of fault visits could cost us £1m: hence the need to strive to reduce faults, especially on the basic instrument, and to reduce visits. The corresponding advantage to the customer may sound small, but it is significant especially in cost terms.

Sv5 (01-432 9015)

Digital timer for coinbox mechanisms

Have you ever suffered frustration or eye-strain using a scale and pointer to adjust POA coin collecting box mechanisms? If so, you will like to know that relief is coming from a digital timer system we have developed from an idea put up by NETR.

This system measures electrically the time between contact operations and displays it numerically on the timer; you compare this reading with a table of the readings that you should get, and adjust accordingly. Unlike tests with the scale and pointer the tests are made while the mech is running at its normal operating speed, just as when a customer makes a call. No need to check continually that your datum setting is OK, just put a test disk through the mech, compare the reading with the table and the job's done. How accurate is it? With the timer system you're taking readings to 1/1000 of a second, that means about 1/48 of a degree on your scale and pointer! Why do we need to be so accurate? Simply because the better the adjustment the longer the mech will stay in service without attention. And service is what our job is all about. You can now be absolutely certain that when a mech leaves you to go into service its adjustments are one hundred per cent.

If the fellow collecting the mech won't believe you, show him the table and run through the checks while he watches. It should convince him and it will only take a couple of minutes.

The digital timer is a tester TRT 240 and you will also need a switchbox no 400082. Both are being distributed to the larger CCB overhaul centres. When you get them, you will be visited by a Regional or Area service team who will brief you on how to operate the timer and how to relate mechanism adjustments to its readings. There is also a very useful TI (E5 C2070) on the subject.

Maurice Bradley of LTR Service Division demonstrating the digital timer to staff of the LTR North Area CCB overhaul centre – Bert Holmes, George Horne, Tony Gibson and Bill Kempster.

Sv 5.1.5 (01-432 9386)

New PABXs

Strowger-type PABXs have been available to our customers for many years. Those of under 100 lines (PABX nos 1, 2, 5, 6 and 7) are on rental terms, while those above 100 lines (PABX nos 3 and 4) are normally customer purchased. All PABXs, because of their direct connexion to the public network, must be PO maintained.

In the late 1960s the PO was faced with pressure from its more influential customers and from sections of the telephone industry, who were aware of current development in this field abroad. The PO agreed to allow customer purchase, by competitive tender, of new proprietary designed common control systems in the 'over 100 line' range. Such systems use crossbar switches, high speed rotary switches or electronic devices in the switched paths and are able to give improved facilities compared with those available from Strowger. An important factor from the customers' point of view is that the system designs allow a high degree of automated factory assembly, giving considerably reduced delivery and installation times compared with those currently on offer for PABXs 3 and 4.

PO Approval

A condition of the PO agreement is that any system offered to customers must be approved by the PO as suitable for connection to the public network. The approval process requires the manufacturer or supplier to submit details of their equipment for PO study and to arrange for a small number of installations to be observed for performance in service over a limited period. Approval for unrestricted installation is given only when the PO is satisfied that the facilities offered, and the performance given, meet the conditions specified in documents called 'Post Office Requirements' (PORs).

The new systems

The table shows the range of systems currently under consideration. Only the

System	Manufacturer/supplier	Capacity (extensions)	Switching equipment
PB 480	Plessey/Telephone Rentals	480	5005 crossbar
PB 1000	Plessey/Telephone Rentals	1000	5005 crossbar
PB 8000	Plessey/Telephone Rentals	8000+	5005 crossbar
PT 6000	Plessey/Telephone Rentals	P.W. tandem switching unit	5005 crossbar
Pentomat P200D	Bell (Antwerp)/STC	200	Pentaconta crossbar
Pentomat P1000T	Bell (Antwerp)/STC	9000	Pentaconta crossbar
ARD 561	LME/SET	270	LME crossbar
AKD 791	LME/SET	9000	LME codeswitch
AKM 303	LME/SET	P.W. tandem switching unit	LME codeswitch
UH 200	Philips/Pye/TMC	200/300	Rotary switch with common drive
UH 900	Philips/Pye/TMC	600/900	Rotary switch with common drive
PREX	Gentel/Thorn	3200	Encapsulated reed
IBM 3750	IBM	2264	Semi-conductor with computer control

ARD 561 has yet been given the stamp of approval but several are on the threshold. It will be seen that they tend to fall into a number of generic categories, depending on manufacturer. All are of the common control type with register storage of digits. The trunking and circuit arrangements are of course particular to each system but those within a generic group have a high degree of affinity. The manual switchboards associated with these PABXs are of the small cordless type.

Maintenance philosophy

In common with the public exchanges of the crossbar and electronic type the call failure rates are low. The switching equipments are generally proving reliable and hence the need for routine maintenance attention is minimal.

The maintenance philosophy is therefore corrective rather than preventive and maintenance attendance is only required when a fault report suggests a failure within the exchange equipment. The smaller systems can be faulted satisfactorily by making test calls from a special test telephone, while larger systems have available fault printout facilities, call fail metering devices for monitoring the service and portable functional testers.

Tools, testers, spares and documents

For the trial installation, tools, testers and an agreed stock of maintenance spares are provided by the manufacturer without charge to the PO. The adequacy of these items is assessed as part of the type approval exercise, the PO then assuming responsibility for subsequent provision. Arrangements are in hand for P&SD to centrally stock tools and spares from which local supplies will be drawn.

With regard to the documents required for acceptance and maintenance, it is the manufacturers' responsibility to provide these at all installations.

Training

Satisfactory maintenance of these new systems depends to a large extent upon the availability of suitable training facilities. A GM may have only a month or two's notice of the bringing into service of PABXs due to the comparatively short delivery and installation times. If a PABX is the first of its kind in the locality there may be a need for the staff who will accept and subsequently maintain it to receive training on the system urgently and at short notice.

Training for the trial installations is given by the manufacturer, and subsequently by the TTC at Stone. TTC feel that they may be hard pressed to always have a course running just when it is needed. Further, in the case of some of the larger systems, the high cost of training models and the expectation that comparatively few systems will be installed may give cause to doubt the economic viability of TTC training, and hence require manufacturer-based training to be acceptable as a permanent feature.

Maintenance guidance

Since, prior to type approval, it is not possible from PO sources to provide detailed instructions for a system, the trial installations must be maintained under general guidance from the manufacturer with the help of THQ. On type approval, TIs are published giving information about the system, maintenance procedures, lists of spare parts, and any known fault-finding techniques. A general TI, E5 D2510, will be issued shortly and system TIs will follow in due course.

Work units

The current method of assessing the work unit value applicable to a PABX solely on the number of working extensions takes no account of ancillary equipment and private circuit terminations. This has led to criticism of the limited time allocated for maintenance.

Proposals are in hand for revising the basis of assessment for Strowger PABXs in order to relate the work unit allocation to the quantity of switching equipment, that is to rental size for the small Strowger PABXs and to the number of switches, relay sets and so on for the larger ones. The assessment of work unit values for the common control type PABXs will follow similar lines.

Conclusions

We have seen that PABXs, in common with main exchanges, are developing to make use of the latest technological advances. Our customers are anxious to use the improved facilities and installation times offered by these developments.

The PO, while approving new PABXs to ensure that they meet the standards required in the public network and to avoid unnecessary proliferation of systems, has a responsibility to meet the needs of its customers.

Sv 5.3.1 (01-432 9145)

Connecting NU tone to out-of-order business lines

If a telephone line is out of order callers should receive NU tone. In fact, they are at present much more likely to receive engaged tone, or even worse, ringing tone no reply. Why? Because in many cases maintenance staff make no use of the facilities available for the connection of NU tone, for example, test and plug-up circuits (T&PU). From the customer's point of view, this is a pretty poor show and to our business customers it can be an embarrassment, leading to considerable loss of business.

Connecting lines to T&PU takes time — not a lot — but none the less if all OOO lines were thus connected it could use up a substantial amount of exchange maintenance time. Indeed it is largely this that has resulted in the facility falling into disuse. Investigations have shown, however, that if the NU tone is connected only to OOO business lines this will involve less than half an hour overall each day, even at the largest exchanges.

TIs E13 B0010 and B0015 have been revised, and repair control officers and exchange maintenance officers are instructed to connect NU tone to OOO business lines or where specifically requested by the customer. At most exchanges this will involve using the T&PU circuits. Where these are not provided TOS procedures should be used. At TXEs and TXKs, PG circuits will be 'parked' automatically but lines that are 'dis' should be made NU using the TOS facility. To reduce the number of extra visits required to unattended exchanges the connexion of NU tone should only be done if the fault is liable to be carried forward.

The important thing is for EMOs and RCOs to get into the habit of connecting NU tone where appropriate. In this way we can improve our relations with customers at little cost to ourselves.

Sv 5.1.3 (01-432 1386)

Dropwire fault locating and renewal

The standard method of providing service from a pole to a customer is by using cable, dropwiring 3 or 4. Both of these have copper clad steel conductors. Any imperfection in the insulation allows the ingress of water and the steel wire quickly corrodes giving a disconnexion, usually on one conductor. As the dropwire is generally erected in a single length between the distribution pole and the customer's premises, difficulty can be experienced in identifying the exact position of a disconnexion fault within the dropwire, without cutting it. This has meant that in many cases the whole length of dropwire has been renewed when one span would have been adequate.

We have investigated this problem and after extensive field trials are satisfied that an accurate location of disconnexion faults can be obtained by using the tester 132B — already available to each faultsman to locate pairs in cabinets and pillars — and a small flexible aerial which can be plugged into the amplifier associated with the tester. The tester 132B comprises an oscillator 87B and an amplifier 109B with receiver headgear 16T. If the oscillator is connected across the line at the customer's telephone, without disconnecting the instrument, the tone can be detected in the dropwire up to the position of the disconnexion. At this point the tone will completely disappear. The aerial enables the tone to be heard from ground level when the operator walks under or near the route. The use of the tester eliminates repeated pole climbing. If there is no access to the customer the oscillator can be connected in series with the faulty wire at the DP and the fault located in the same way.

This method is not effective for locating other types of faults, such as noisy lines or short circuits. Also some difficulty may be experienced in detecting the tone when interference from neighbouring overhead power lines is present, or the dropwire is shielded from the ground by heavy foliage.

National introduction of the technique has been delayed because it has been necessary to redesign the amplifier 109B to overcome various difficulties, one of which is the poor connexion provided by the existing coaxial output socket. It is hoped that the new amplifier and associated aerial will be available by autumn 1973.

When the fault is located it is only necessary to renew one span or, in the worst condition, when the fault occurs on an intermediate pole, to renew one span each side of the fault.

The renewal of cable dropwiring no 3 has been simplified by the recent introduction of a new technique using the dropwire dispenser no 1. Up to two spans can be renewed by using the existing dropwire as a drawline and drawing the new dropwire off the dispenser and over pulleys into the original position of the faulty dropwire. The great advantages of this method are that the faulty dropwire can be safely recovered, the new dropwire is erected without risk of kinking and introducing potential faults, and it can be erected safely over obstructions or roads by a solo faultsman.

The method of renewal is similar in all cases and is fully described in TI E2 C1052. At one pole a sash line, which is fed through a pulley at the pole-head and anchored to a pole belt near the base of the pole, is attached to the existing dropwire by means of a dropwire clamp. The dropwire is then cut. At the far end of the span(s) the new dropwire from a dropwire dispenser is similarly fed through a pulley and attached to the faulty dropwire by means of another clamp. The dispenser is first tensioned and the dropwire is cut so that it is supported at one end by the tension on the dispenser, and at the other by the sashline, preventing the span from sagging. The faultsman returns to the first pole and pulls the sashline followed by the faulty dropwire until the new dropwire is in place. The new dropwire is then connected to the existing by use of dropwire connectors, wrapped in tape, sealing no 3 — 2 in. The method can also be used for renewing open wires with dropwire, and provided no road or power crossing is involved, one span of dropwire 1. Other types of dropwire are too heavy for this technique to be used and cannot be safely controlled by one man.

Sv 5.1.1 (01-432 1373)

Locator 6a for faults in buried polyethylene cables

Earth faults in the local line network are a common occurrence, and many of them are in the minor distribution cables of which a considerable proportion are buried unarmoured polyethylene sheathed. Hence much of a faultsman jointer's time is spent in locating and digging out buried joints and damaged cables.

Tests made with an ohmmeter 18A enable the faultsman to obtain an accurate measurement of resistance to the fault, but frequently the estimated fault position is incorrect. Loops of slack cable left in the ground from the initial installation period, unrecorded changes in conductor size, and the close proximity of cable joints all contribute to the error. However, an earth fault location method has been in use for some years for proving the fault position before an attempt is made to excavate and effect repair. The technique reduces plant disturbance, out of service times, and manual effort. It was originally based on an awards suggestion from Preston Area.

The testing technique is relatively simple. It consists of applying an interrupted tone between the bunched faulty pair and earth, with two electrodes connected to

an amplifier/receiver. The route of the cable is searched until the tone leaking into the surrounding soil at the fault point is detected in the receiver. Except for initial pick-up at the point where the oscillator is connected, negligible tone is heard in the receiver until in the vicinity of the fault position. Initially two men were required for the test, each man acting as an electrode, but with the introduction of solo working a change was necessary and many staff are now using a locally made earth probe, which enables one man to make the test. In this arrangement resistive coupling is made to earth by the metal spike of the probe and the faultsman acts as the second electrode. An oscillator 99A and an amplifier 109B, which are part of a faultsman's standard equipment are used for the test.

The earth probe has proved very useful but some disadvantages have shown up during general field use, the main ones being:

1 Not very successful on made up surfaces (tarmacadam etc), especially under dry conditions.

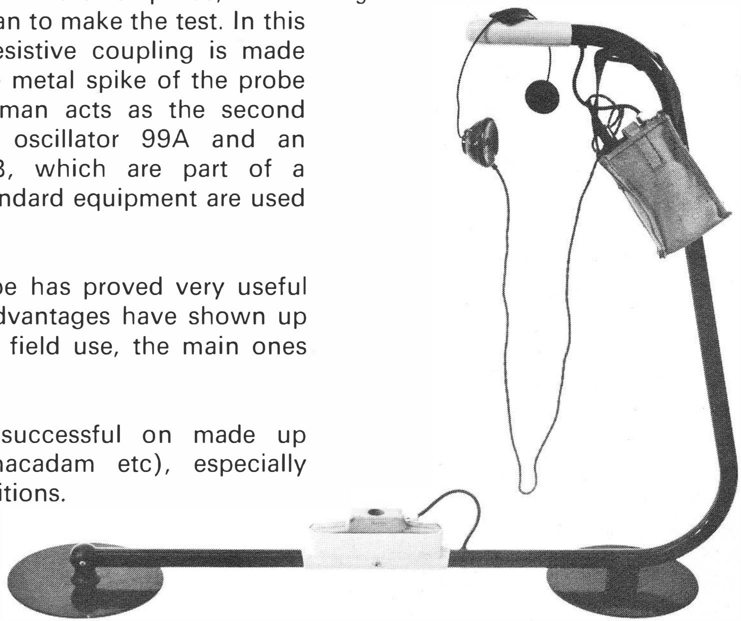
2 Inconsistent level of pick-up.

3 No track locating facility.

To improve pick-up of tone over the fault and provide for track location the locator no 6A has been developed and will shortly be available for general issue to faultsman jointers.

The locator, see figure 1, comprises a simple C-shaped tubular steel frame with two insulated circular plates fitted on the lower arm and spaced at approximately 750 mm centres. A changeover switch is provided in the carrying handle and this is wired to the plates and to a search coil 2A which is mounted on the lower arm between the two plates. A lead is also provided from the changeover switch for connexion to the amplifier which is suspended in its carrying case from the upper arm of the frame.

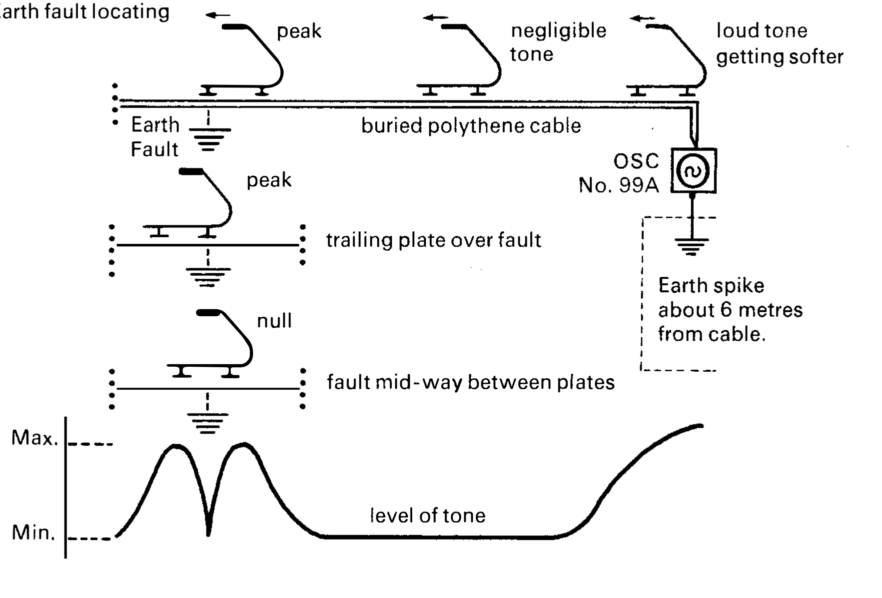
Fig 1.



Field trials have proved the instrument to be far more efficient than the locally constructed earth probe and it is satisfactory for cables buried under all types of surfaces. Capacitive coupling through the two circular plates improves the electrical balance by eliminating the faultsman jointer from the circuit. When the operator switches in the search coil, which detects the magnetic field due to the tone current, he receives maximum tone to either side of the cable track and searches for no tone over the track. When he switches the amplifier to the plates he searches similarly for tone from the fault. Thus he can confirm track position and search for the fault in one continuous operation.

The output of the oscillator 99A is connected between the bunched faulty pair and an earth spike situated several metres from the cable. With the locator held in line with the track, the amplifier switched on, and the two plates held slightly above ground level the operator proceeds to walk in the direction of the fault position listening every few metres for pick-up of the tone from the fault condition and at the same time verifying the cable position by operating the changeover switch to the track locate position. Approaching the fault a maximum tone will be initially detected when the leading plate is above the point of earth leakage, followed by a 'null' point (no tone) and a further maximum tone when the trailing plate is above the fault. Returning the locator to the 'null' position will give the most accurate location as this is more readily discernible than a maximum signal. The 'null' position is generally at mid point between the two plates. Typical distribution of the tone level between the fault and the point of application of the oscillator is shown in figure 2.

Fig 2. Earth fault locating



Except for occasions when high levels of ac mains interference from adjacent power cables may render the method less effective, the overall interpretation of the test is not difficult, and accurate results to within a spade's width can be obtained over sections of cable of the order of 1 km.

There are other points to bear in mind when using the locator. Firstly, the location given will be that position where the tone is leaking to earth and need not necessarily be the position where the fault is affecting the wire. For example, if water has entered a cable through a damaged sheath and has travelled to an adjacent joint, or to some other point where the conductor is exposed, the test will locate the point of the damaged outer sheath. Secondly, the test will not locate earth faults between conductors in a cable unless there is also a leakage to earth through the cable sheath. Lastly, occasionally more than one 'null' point may be detected, but with experience it is possible to determine the position of the real fault by virtue of the loudness of the maximum tone. The less significant 'null' points will probably be due to incipient faults developing through ingress of moisture into cable joints.

Sv 5.1.1 (01-432 1373)

Self-inflicted wounds

Some of the most spectacular damage to the trunk and junction network is caused by the operations of outside agencies such as earth moving contractors. About 1200 cases of such damage to our network occur each year. Related to the length of the cables involved, this amounts to a rate of 0·71 cases for every 100 km each year. A continuous campaign of press notices, publicity cards, stickers, exhibitions and so on is being waged in an effort to prevent or reduce this damage.

But we suffer more cable damage cases from PO and our own contractors' staff than we do from those outside. There are some 2000 cases of self-inflicted damage each year. Related again to the network length, this amounts to 1·1 cases for every 100 km each year, or half as much again as those caused by the much maligned outsider.

What can we do to reduce our self-inflicted wounds? *Maintenance News* may be preaching to the converted, but the first thing to say is that maintenance staff can influence their construction colleagues and others working on the network, in helping to reduce damage.

So take a keen interest in what other groups are up to when they work on cables in your patch. Point out to them in a friendly way the particularly vulnerable cables, for instance the older coaxial cables with soldered inner conductors. Let your EPMC know of the work going on. A chat with pole erection unit staff when you see them working near a cable track could save a major repair job (T1 A2 N1203 para 6 tells them how to detect obstacles).

Point out in a friendly way

The majority of our cable defects occur in jointing chambers, so keep a sharp look out for potential trouble when working there. Points to watch for are detailed in a new T1 E3 EO111 which has just been issued. In particular look out for poorly supported cables and joints. If you are unable to effect a permanent remedy right away do your best to provide temporary support and let the EPMC know.

Many a cable length has been lost through temporary joint closures failing to keep out water. The moral of this is to make a permanent job of the joint as soon as possible when making a temporary closure. T1 E3 A3015 describes the method of using self-adhesive rubber sheet for closures which are proofed against water for up to seven days.

The A60 procedure, where cables are temporarily taken out of traffic for maintenance purposes, is a source of service affecting fault reports where agreed times of restoration are overrun. Try to avoid this by carefully calculating the time required. If an overrun is unavoidable, contact the RNCC as soon as possible — the telephone number is quoted on the A60 advice.

Our main defence against water entering cables is pressurisation. All too often, exchanges are isolated because of wet joints in their outlet cables. So keep a sharp watch on pressure and flow gauges. Deal with pressure alarms promptly and, if the fault cannot be cleared right away, arrange for a temporary additional air supply in the vicinity of the leak.

Cables are very easily damaged and the consequences, particularly in the case of those carrying coaxial systems, can be very severe. Treat them with extra respect and encourage your colleagues to do likewise so that we can reduce those 2000 self inflicted wounds suffered every year by the trunk and junction network.

If damage does occur, in particular water entering the core, and a permanent repair is not immediately possible, try to prevent further damage and don't forget to let your control know of the position as soon as possible.

Sv 5.2.2 (01-432 1306)

Plant protection officers

The safeguarding of external plant from damage has, in the past, been in the hands of plant watchers who were graded either as Technicians 1 or 2A. One of their main tasks was dealing with incoming statutory notices from authorities and undertakings working in the vicinity of PO external plant. In many cases procedures to prevent avoidable damage during street works were found inadequate.

The external plant protection work and the control of incoming statutory notices is now being transferred to External Plant Maintenance Controls (EPMCs). Plant watchers are being replaced by Plant Protection Officers (PPOs) and their work will be issued by an External Plant Maintenance Control Officer (EPMCO). PPOs will have the rank of T1. New PPOs who are not already T1s will be required to qualify at a two week training course, at either Shirehampton or Didsbury.

The duties of a PPO include the following:

a Locating and marking PO cable tracks to enable excavation to be undertaken without damage.

b To observe and advise on back-filling near PO external plant.

c To supervise minor cases of shifting of plant to facilitate excavations.

d To check the adequacy of electricity crossings and clearances.

e To investigate and report on cases of damage.

f To make temporary first aid damage repairs prior to the arrival of a maintenance party.

One of the major differences in the working of a PPO from a plant watcher is that a PPO will not normally attend a work site unless requested to do so by the authority or undertaking concerned. Such requests will usually be made direct to the EPMC by means of the Freefone One Double One system, where the caller dials the operator, requests Freefone One Double One and is connected free of charge to the EPMC. This method of working is expected to enable substantial transport economies to be made without increasing the number of damage cases.

There will be fewer PPOs than plant watchers but by their ability to be directed quickly to where they will be immediately required and by their extra training, external plant protection should be more effectively provided.

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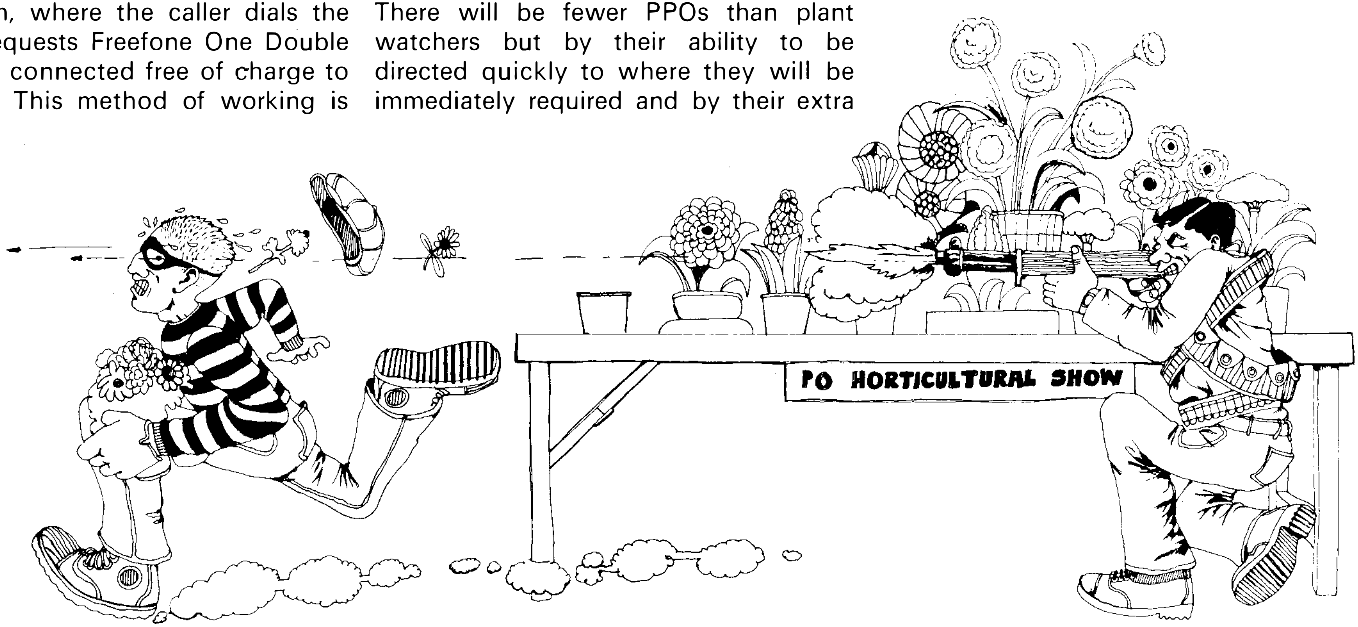

Defects and difficulties - The A646 procedure

May we remind you that it is important all circuit difficulties, items found defective in service and manufacturing defects in engineering stores are reported quickly to your supervising officer on form A646, giving all the relevant information asked for on the front of the form. The case will not then suffer delay where there is a risk of fire or accident; moreover in less urgent cases you will still be helping to keep defects and difficulties away from your colleagues.

When the supervising officer receives the A646, he will investigate the difficulty or defect and enter his observations on the back of the form. This is then forwarded to the Head of Division (Maintenance) who will have the matter cleared locally if the answer is already known.

If it is a new case or further advice is required the form is forwarded to RHQ with the Area comments. RHQ may be able to advise or take action; if not the A646 is passed to THQ.

This feedback of information enables the necessary action to be taken by THQ to modify design or correct manufacturing defects. To assist this action the information on the front of the A646 is invaluable. In fact, if vital information is not given, valuable time is lost in referring back in an endeavour to obtain it. So please give all the information first time.

Do not delay while you think up a solution for an awards case. If you do put in a suggestion under the Awards Scheme later on, mention that you had forwarded an A646 earlier.

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